BIFURCATION PERCUTANEOUS CORONARY INTERVENTION
...Is there always more than meets the eye?...
Coronary artery bifurcations present a harmonious asymmetric geometry that is fractal in nature.

The branching systems in our body (vascular and bronchial trees) and those in the environment (plant trees and river systems) are characterized by a fractal nature:

the self-similarity in the bifurcation pattern

DEFINITION OF A FRACTAL:
any of various extremely irregular curves or shapes for which any suitably chosen part is similar in shape to a given larger or smaller part when magnified or reduced to the same size

Fractal Geometry. B. Mandelbrot 1975
The fractal nature of vascular trees

- Blood flow distribution dictates vascular geometry
- The law of conservation of mass: the sum of the outflows from bifurcations equals inflow
- Relation between function (blood flow) and geometry (cross sectional area and diameter)

G. Stankovic ESC Congress 2011
Structure - function scaling laws of vascular trees

Scaling principle governing vessel diameters in a bifurcation


http://www.et.iupui.edu/cnc/refdiacalculation.aspx
Types of involvement of coronary bifurcations by atherosclerosis

- Atherosclerosis occurs predominantly close to bifurcation
- Carina involvement is extremely unusual

Courtesy of Dr. Renu Virmani
Low ESS is a major stimulus for atherogenesis and plaque progression

Ku DN. et al. Arteriosclerosis 1985; 5 : 223
Wentzel JJ. Et al CIRCULATION 2003; 108 :17
Cheng C. et al. Circulation 2006; 113 : 2744
Lateral walls of bifurcations susceptible to atherosclerosis

...Is there always more than meets the eye?...
(bifurcation and flow modification)

taken from G. Giannakoulas  EBC 2008
Is carina free of atherosclerosis?

Effect of bifurcation angle on flow perturbations and atherosclerosis

- Increased bifurcation angle intensifies flow perturbations and low ESS environment in the lateral walls rendering them more susceptible to atherosclerosis

Markl M et al. In Vivo Wall Shear Stress Distribution in the Carotid Artery Effect of Bifurcation Geometry, Internal Carotid Artery Stenosis, and Recanalization Therapy
Bifurcation PCI: What are the main objectives?

- To restore the natural configuration (FRACTAL) in bifurcation:
  - optimal rheology
  - stent well apposed
  - easy access in the future
Bifurcation PCI

- Coronary artery bifurcation lesions: a complex lesion subgroup, 15–20% of all percutaneous coronary interventions
- Lesion heterogeneity potentially affects procedural success, complications rate and long-term outcomes
- Inability to standardize the techniques
- The more suitable PCI strategy should be selected and optimized on an individual basis

Does Bifurcation Morphology Matter? Bifurcation PCI classification

A new classification of coronary bifurcation lesions.
What is a complex bifurcation? Bifurcation PCI classification

Classification of coronary artery bifurcation lesions and treatments: time for a consensus!
Why are we still concerned about bifurcations?

- Side branch occlusion / or severe compromise
- Stent thrombosis
- Restenosis and repeat interventions
Provisional SB stenting vs. systematic 2-stent approach:  
*lex parsimoniae or Ockham's razor*

"simpler explanations are, other things being equal, generally better than more complex ones."

William of Ockham (c. 1288 – c. 1348)
BMS vs DES

Biondi Zoccai et al. ESC 2008
### The Evidence

**“Low Risk” Bifurcations**

<table>
<thead>
<tr>
<th>Study</th>
<th>NORDIC</th>
<th></th>
<th>BBK</th>
<th></th>
<th>CACTUS</th>
<th></th>
<th>BBC-ONE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elective</td>
<td>Provisional</td>
<td>Elective</td>
<td>Provisional</td>
<td>Elective</td>
<td>Provisional</td>
<td>Elective</td>
<td>Provisional</td>
</tr>
<tr>
<td>N</td>
<td>206</td>
<td>207</td>
<td>101</td>
<td>101</td>
<td>177</td>
<td>173</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Technique</td>
<td>Crush &amp; Culotte</td>
<td>TAP</td>
<td>Crush</td>
<td>Crush &amp; Culotte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Outcome</td>
<td>6 months</td>
<td></td>
<td>1 year</td>
<td></td>
<td>6 months</td>
<td></td>
<td>9 months</td>
<td></td>
</tr>
<tr>
<td>Primary End Point</td>
<td>Death, MI, TVR or ST</td>
<td>% DS of the SB</td>
<td>Death, MI, TVR</td>
<td>% DS of the SB</td>
<td>Death, MI, TVR</td>
<td>% DS of the SB</td>
<td>Death, MI, TVF</td>
<td>% DS of the SB</td>
</tr>
<tr>
<td></td>
<td>3.4%</td>
<td>2.9%</td>
<td>27.7</td>
<td>23.0</td>
<td>15.8%</td>
<td>15%</td>
<td>15.2%*</td>
<td>8%*</td>
</tr>
<tr>
<td>Non-fatal MI (%)</td>
<td>0.5</td>
<td>0.0</td>
<td>2</td>
<td>1</td>
<td>10.7</td>
<td>8.6</td>
<td>11.2*</td>
<td>3.6*</td>
</tr>
<tr>
<td>Stent thrombosis (%)</td>
<td>0.0</td>
<td>0.5</td>
<td>2</td>
<td>1</td>
<td>1.7</td>
<td>1.1</td>
<td>2.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Angiographic outcome</td>
<td></td>
<td></td>
<td>8 months</td>
<td>9 months</td>
<td>6 months</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Restenosis (%)</td>
<td>MV</td>
<td>SB</td>
<td>MV</td>
<td>SB</td>
<td>MV</td>
<td>SB</td>
<td>MV</td>
<td>SB</td>
</tr>
<tr>
<td></td>
<td>5.1</td>
<td>11.5</td>
<td>4.6</td>
<td>19.2</td>
<td>3.1</td>
<td>12.5</td>
<td>7.3</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>4.6</td>
<td>13.2</td>
<td>6.7</td>
<td>14.7</td>
<td>4.6</td>
<td>13.2</td>
<td>6.7</td>
<td>14.7</td>
</tr>
</tbody>
</table>

*P<0.05*
Table 4. Randomized Bifurcation Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>No. Patients</th>
<th>Randomization</th>
<th>Primary End Point</th>
<th>Outcome (Provisional vs Systematic Unless Otherwise Specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORDIC</td>
<td>413</td>
<td>Provisional vs systematic (crush, culotte, T)</td>
<td>Death, MI (nonprocedural), TVR, or stent thrombosis at 6 mo</td>
<td>2.9% vs 3.4% (P=NS)</td>
</tr>
<tr>
<td>CACTUS</td>
<td>350</td>
<td>Provisional vs systematic (crush)</td>
<td>Death, MI, TVR at 6 mo</td>
<td>15% vs 15.8% (P=NS)</td>
</tr>
<tr>
<td>BBC ONE</td>
<td>500</td>
<td>Provisional vs systematic (crush, culotte)</td>
<td>Death, MI, TVF at 9 mo</td>
<td>8.0% vs 15.2% (P&lt;0.05)</td>
</tr>
<tr>
<td>Ferenc et al</td>
<td>202</td>
<td>Provisional vs systematic (T)</td>
<td>Angiographic restenosis (side branch) 9 mo</td>
<td>23.0% vs 27.7% (P=NS)</td>
</tr>
<tr>
<td>Colombo et al</td>
<td>85</td>
<td>Provisional vs systematic (crush, T, culotte)</td>
<td>Angiographic restenosis (either branch) 6 mo</td>
<td>18.7% vs 28.0% (P=NS)</td>
</tr>
<tr>
<td>Pan et al</td>
<td>91</td>
<td>Provisional vs systematic (T)</td>
<td>Angiographic restenosis (either branch) 6 mo</td>
<td>7% vs 25% (P=NS)</td>
</tr>
<tr>
<td>NORDIC 2</td>
<td>424</td>
<td>Systematic (crush vs culotte)</td>
<td>Death, MI (nonprocedural), TVR, or stent thrombosis at 6 mo</td>
<td>Crush 4.3% vs culotte 3.7% (P=NS)</td>
</tr>
</tbody>
</table>

NORDIC indicates Nordic Bifurcation Study; MI, myocardial infarction; TVR, target-vessel revascularization; CACTUS, Coronary bifurcations: Application of the Crushing Technique Using Sirolimus-eluting stents; and TVF, target-vessel failure.
Simple or Complex Stenting for Bifurcation Coronary Lesions: A Patient-Level Pooled-Analysis of the Nordic Bifurcation Study and the British Bifurcation Coronary Study

Miles W. Behan, Niels R. Holm, Nicholas P. Curzen, Andrejs Erglis, Rodney H. Stables, Adam J. de Belder, Matti Niemelä, Nina Cooter, Derek P. Chew, Terje K. Steigen, Keith G. Oldroyd, Jan S. Jensen, Jens Flensted Lassen, Leif Thuesen and David Hildick-Smith

*Circ Cardiovasc Interv* 2011;4:57-64; originally published online January 4, 2011;

<table>
<thead>
<tr>
<th>913 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-month clinical follow up</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composite endpoint</th>
<th>All-cause death/MI/TVR at 9 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target vessel revascularization (TVR)</td>
<td>Repeat attempted revascularization of target vessel</td>
</tr>
<tr>
<td>Stent thrombosis (ST)</td>
<td>ARC definite</td>
</tr>
<tr>
<td>Procedural success</td>
<td>TIMI 3 flow and &lt;30% stenosis in the main vessel, plus TIMI 3 flow in the side branch.</td>
</tr>
</tbody>
</table>
Freedom from 1° Endpoint
Subgroup Analysis

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Odds Ratio and 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>True bifurcations (657)</td>
<td>1.90 (1.22-2.94)</td>
</tr>
<tr>
<td>Angle&gt;60-70° (217)</td>
<td>1.67 (0.78-3.62)</td>
</tr>
<tr>
<td>SB diameter≥2.75mm (281)</td>
<td>2.42 (1.22-4.80)</td>
</tr>
<tr>
<td>SB lesion&gt;5mm (464)</td>
<td>1.71 (1.05-2.77)</td>
</tr>
<tr>
<td>SB diameter≥2.75mm/lesion&gt;5mm (137)</td>
<td>1.04 (0.68-1.97)</td>
</tr>
<tr>
<td>Equivalence (108)</td>
<td>0.35 (0.48-3.70)</td>
</tr>
<tr>
<td>Total (913)</td>
<td>1.84 (1.28-2.66)</td>
</tr>
</tbody>
</table>

NO ADVANTAGE WITH COMPLEX

Favours Simple  Favours Complex
The Evidence

"High Risk" Bifurcations

The predictive value of bifurcation angle calculated by 3-D QCA from 347 patients. The cut-off value of distal BA for predicting MACE was 60°.

Only in < 60° group DKCrush significantly reduced the rate of TLR, TVR and MACE as compared to provisional stenting group.

Survival-rate free from TLR between < 60 vs. ≥ 60 subgroups in patients receiving two-stent technique.

The Evidence
Who Are the Patients?

SB Lesion Length (mm)

SB Lesion Severity (%)
The Guidelines
Provisional versus Elective SB stenting

Provisional side-branch stenting should be the initial approach in patients with bifurcation lesions when the side branch is not large and has only mild or moderate foal disease at the ostium.

It is reasonable to use elective double stenting in patients with complex bifurcation morphology involving a large side branch where the risk of side-branch occlusion is high and the likelihood of successful side branch reaccess is low.

Provisional vs Double stenting: Conclusions

- Studies: the strategy of systematic stenting MB+SB offers no benefit over stenting the MB only with provisional SB stenting in terms of restenosis rates in both branches, TLR, or overall MACE.

- Implantation of two DES does not appear to be associated with a higher incidence of adverse events at least up to 14 months following the procedure.

- Provisional approach: less technically demanding, associated with significantly less procedure-related biomarker release. Currently considered the primary strategy to bifurcation PCI when anatomically suitable.

Provisional vs Double stenting:

- implanting 2 stents is more complex
- implanting 2 stents is more expensive
- more fluoroscopy time, more contrast
- with 1 stent you jeopardize the SB, but with 2 stents a poor result may affect both the MAIN and the SIDE branch
- and always keep in mind: in single stent techniques the primary stent should be sized according to the DISTAL MAIN VESSEL diameter
- post dilatation POT KB are required to optimise proximal MV stent diameter

Antonio Colombo TCT 2010
Keep it Open. Why Wire Both Branches?

- Response of each bifurcation lesion concerning SB compromise after MB intervention is largely unpredictable
- Protects SB from closure due to plaque shift and/or stent struts
- Jailed SB wire facilitates re-wiring of the SB:
  - widening the angle between the MB and SB
  - by acting as a marker for the SB ostium if SB occludes
  - changing the angle of SB take-off

- Tulipe study: absence of jailed wire associated with higher rate of reinterventions (OR:4.26; 1.27–14.35) during f.u
Keep It Open

- Occlusion of SB’s >1mm associated with 14% incidence of Myocardial Infarction
- Closure associated with large branch can lead to a large periprocedural MI
- Main concern is to keep an adequately large SB open TIMI (1, 2, 3) without concerning about residual stenosis or extent of ischemia

Seal it with a kiss?

Randomised comparison of fractional flow reserve-based (FKBD) vs. conventional coronary stenting with a primary composite end point of MACE (cardiac death, index lesion MI, TLR, stent thrombosis) after 6 months.

Primary composite end point of MACE (cardiac death, index lesion MI, TLR, stent thrombosis) after 6 months

- **FKBD:** 2.1%
- **No - FKBD:** 2.5%

Nordic-Baltic PCI Study Group.
Restenosis was defined as ≥50% diameter stenosis at the 8-month follow-up. In-stent segments included the stented areas of the MV or the first 5 mm of the SB.
Coronary Bifurcation Lesions Treated With Simple Approach (from the Cordoba & Las Palmas [CORPAL] Kiss Trial)

Manuel Pan, MD, PhD\textsuperscript{a,*}, Alfonso Medina, MD, PhD\textsuperscript{b}, José Suárez de Lezo, MD, PhD\textsuperscript{a}, Miguel Romero, MD, PhD\textsuperscript{a}, Jose Segura, MD, PhD\textsuperscript{a}, Pedro Martín, MD, PhD\textsuperscript{b}, Javier Suárez de Lezo, MD, PhD\textsuperscript{a}, Enrique Hernández, MD, PhD\textsuperscript{b}, Francisco Mazuelos, MD, PhD\textsuperscript{a}, Álvaro Moreno, MD, PhD\textsuperscript{a}, Djordje Pavlovic, MD, PhD\textsuperscript{a}, Soledad Ojeda, MD, PhD\textsuperscript{a}, Francisco Toledano, MD\textsuperscript{a}, and Carmen Leon, MD\textsuperscript{a}

AIMS

➢ To compare the incidence of 1-year clinical events in patients with bifurcation lesions treated with simple approach which were randomized to simultaneous final kissing balloon or isolated SB balloon post-dilation using 2 different stent platforms (Cypher \textsuperscript{®} vs. Xience \textsuperscript{®}).
<table>
<thead>
<tr>
<th>MACE</th>
<th>SIROLIMUS (n=141)</th>
<th>EVEROLIMUS (n=141)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-month outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CK post (iu/l)</td>
<td>129 ± 130</td>
<td>138 ± 160</td>
<td>ns</td>
</tr>
<tr>
<td>Non Q AMI</td>
<td>2 (1.4%)</td>
<td>2 (1.4%)</td>
<td>ns</td>
</tr>
<tr>
<td>Surgery</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>Death</td>
<td>1 (0.7%)</td>
<td>1 (0.7%)</td>
<td>ns</td>
</tr>
<tr>
<td>1-year outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>0</td>
<td>0</td>
<td>ns</td>
</tr>
<tr>
<td>Death</td>
<td>4 (2.8%)</td>
<td>1 (0.7%)</td>
<td>ns</td>
</tr>
<tr>
<td>TLR</td>
<td>3 (2.1%)</td>
<td>2 (1.4%)</td>
<td>ns</td>
</tr>
<tr>
<td>Remote intervent</td>
<td>4 (2.8%)</td>
<td>2 (1.4%)</td>
<td>ns</td>
</tr>
<tr>
<td>TOTAL MACE</td>
<td>9 (7%)</td>
<td>6 (4%)</td>
<td>ns</td>
</tr>
</tbody>
</table>
Final kissing ballooning and long-term clinical

Comparison of major adverse cardiac events for subgroups.
How to Optimize Results with Provisional Stenting

- Use 6 Fr. Guide catheter
- Wire both branches
- Pre dilate the MV
- Pre dilatation of SB on a case by case basis
- Stent the MB, leaving the wire in the SB
- Rewire SB and then remove jailed wire
- KBI if needed
- Stent SB only if “suboptimal” result
Why 1 Stent probably is sufficient? SB Lesions are Usually Short!!

<table>
<thead>
<tr>
<th></th>
<th>Bestent(^1)</th>
<th>TULIPE(^2)</th>
<th>Sirolimus(^3)</th>
<th>Sirolimus(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>105</td>
<td>187</td>
<td>85</td>
<td>47</td>
</tr>
<tr>
<td>Reference (mm)</td>
<td>2.7±0.4</td>
<td>2.3±0.5</td>
<td>2.1±0.3</td>
<td>2.1±0.5</td>
</tr>
<tr>
<td>Lesion length (mm)</td>
<td>5.6±4.2</td>
<td>3.7±3.3</td>
<td>5.3±4.2</td>
<td>4.5±3.0</td>
</tr>
<tr>
<td>Stenosis SB (%)</td>
<td>49±37</td>
<td>52±17</td>
<td>52±19</td>
<td>42±23</td>
</tr>
</tbody>
</table>

Significant SB LL>3mm→ 10-24%

Gobeil et al. Am J Cardiol 2001
Sengotuvel et al. JACC2004 (abst.supp.)
How often do we need 2 stents?

2 stent techniques

- The approach is dictated by the SB:
  - True vs. Non-true
  - Size of SB
  - Extent and distribution of disease in SB
  - How important the side branch is for that patient and for that specific anatomy

2 stent techniques

- the significance of the SB for the individual patient is determined by defining its diameter and the amount of myocardium subtended

- elective implantation of two stents: “true” bifurcations with SB ≥ 2.5 mm in diameter, a large dependent area, and disease extending > 5 mm from the ostium

2 stent techniques as ITT

- provisional T stenting remains the gold standard technique for most bifurcations
- Large side branches with ostial disease extending >5 mm from the carina are likely to require a 2 stent strategy
- Side branches whose access is particularly challenging should be secured by stenting once accessed

2 stent techniques as ITT advantages:

- lower risk of SB closure during MB stent implantation
- less difficulties in recrossing through stent struts with the second stent
- full lesion coverage (crush, culotte, V-stent)
Which technique?

Contemporary Stent Treatment of Coronary Bifurcations

The V/Simultaneous Kissing Stents Technique

Contemporary Stent Treatment of Coronary Bifurcations

The Crush Technique

Applications:
- Left Main
- Large branches
- Angulation < 90°
- Significant disease at the proximal vessel

Considerations:
- Combined stent size should "match" vessel size proximal to the bifurcation
- Single high pressure balloon inflation in the SB before FKB may be helpful to optimize stent expansion

Contemporary Stent Treatment of Coronary Bifurcations

The T-Stenting Technique

Applications:
- Angulation > 75°
- SB with severe stenosis at the ostium location

Considerations:
- Accurate position of SB stent is critical for SB ostium coverage

Contemporary Stent Treatment of Coronary Bifurcations

The Culottes Stenting Technique

Applications:
- Left Main
- Large SB
- Angulation > 75°
- Restenosis in-stent

Advantages:
- Optimized stent expansion in both branches
- Suitable for lesions with wide angles

Considerations:
- Both advancement of 2nd stent through metal struts
- Re-wiring for FKB

Conclusions:
- High metal concentration at the bifurcation carina

IPOR:
- Final kissing balloon
- SB: side branch
- PV: parent vessel

Nordic I & II & BBC One metaanalysis
Which complex technique?

Included by intention to treat

BBC ONE, Nordic-Baltic Bifurcation I + II

Crush (n=500)

Culotte (n=413)

Culotte (n=424)

Crush (n=169)

Crush (n=75)

Crush (n=103)

Crush (n=207)

Culotte (n=214)

MACE

9.6% vs. 9.3% HR 1.05 CI(0.6-1.7); p=0.78

Death + non-procedural MI + TVR

The crush and culotte two-stent techniques were associated with similar 9-month clinical outcome

Niels R. Holm
Two-stent techniques were associated with a trend for increased MACE rates in shallow angle bifurcations. Similar MACE rates for crush and culotte techniques were observed. The crush technique was associated with a trend towards more procedural MIs in angulated lesions.

**Final Kissing Balloon**

Total MACE (n=811): Kiss vs. No-kiss: 9.6% vs. 14.2%, p=0.01

- **MACE**
  - Total MACE: Kiss vs. No-kiss
  - More non-proc. MIs
    - Crush: 9.1%, 8.0%
    - Culotte: 11.7%, 22.6%
  - Proc. MI
    - Kiss: 12.0%
    - No-Kiss: 9.1%, 12.5%

TVR=19.6% ST=10%

---

Niels R. Holm
Influence of Bifurcation Angle on Outcome of Crush Technique

Kaplan-Meier plot comparing MACE-free survival up to 648 days between the low-angle group (BA < 50°) and high-angle group BA > 50°.
Which technique?

An approach for bifurcational lesions when using 2 stents as intention to treat:

- no disease proximal to the bifurcation or very short LM
- MB disease extending proximal to the bifurcation and SB which has origin with about 90° angle
- MB disease extending proximal to the bifurcation and SB which has origin with about 60° angle

V-Stent/SKS

T-Stent/Culotte

Culotte/Crush

Pre
Post
Pre
Post
Pre
Post

<table>
<thead>
<tr>
<th></th>
<th>PRO</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modified T Stenting</td>
<td>- Immediate patency of both branches.</td>
<td>- Not optimal for Y bifurcations.</td>
</tr>
<tr>
<td></td>
<td>- Good coverage of SB ostium with limited deformity.</td>
<td>- Requires wire/balloon re-crossing of one branch.</td>
</tr>
<tr>
<td></td>
<td>- Utilized in the RCTs</td>
<td></td>
</tr>
<tr>
<td>Mini Crush Stenting</td>
<td>- Immediate patency of both branches</td>
<td>- Not optimal for T bifurcations.</td>
</tr>
<tr>
<td></td>
<td>- Can be used in a wide variety of bifurcation morphology.</td>
<td>- Stent deformity at the SB ostium.</td>
</tr>
<tr>
<td></td>
<td>- Utilized in the RCTs</td>
<td>- Requires wire / balloon re-crossing of one branch.</td>
</tr>
<tr>
<td>Culotte Stenting</td>
<td>- Provides the best coverage and the least strut deformity at the SB</td>
<td>- Not optimal for patients with:</td>
</tr>
<tr>
<td></td>
<td>ostium.</td>
<td>• Large mismatch between MV and SB size</td>
</tr>
<tr>
<td></td>
<td>- Utilized in the RCTs</td>
<td>• Critical stenoses in the MV and SB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• One branch is unprotected during the procedure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Requires rewiring of both branches.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Limited utility with closed cell design stents.</td>
</tr>
<tr>
<td>V Stenting</td>
<td>- Easy</td>
<td>- Should be used only in 0,1,1 bifurcations.</td>
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<td></td>
<td>- Preservation of patency and wire access to both branches at all</td>
<td>- Potential for asymmetric stent expansion.</td>
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<td>stages.</td>
<td>- Not utilized in the RCTs</td>
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<tr>
<td>SKS Stenting</td>
<td>- Easy</td>
<td>- Creation of permanent new metal carina.</td>
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<tr>
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<td>- Preservation of patency and wire access to both branches at all</td>
<td>- Asymmetric stent expansion</td>
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<td>stages.</td>
<td>- Difficulty in re-access at FU</td>
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<td>- Not utilized in the RCTs</td>
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Technical Factors that May be Important in Reducing Restenosis & TLR when 2 Stents Implanted in Bifurcations

- High pressure side branch inflation
- 2-step Kiss: Pre-FKI side branch dilatation
- Use of low-compliant balloons
- Less protrusion of SB stent into MB (mini-crush)
- IVUS-guided stenting (INSIDE Trial)
FKI was performed in 90.0% in the A family and 67.1% in the S family;

The incidence of hard-endpoint of S-family with FKI was comparable to A-family, whereas S-family without FKI showed the poorest prognosis (1.1% vs. 15.9%, P = 0.011).
Open issues with bifurcations

- technically demanding
- time consuming
- too much operator dependent
- off the-shelf standard stents don’t fit bifurcations
- long term outcome?
Is new technology going to be the answer?


Is new technology going to be the answer?
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The bifurcation is a True Bifurcation (significant stenosis on the MB and SB)

- No
  - Provisional SB stenting

- Yes
  - The SB is suitable for stenting
    - No
      - Stent on MB
    - Yes
      - The disease on the SB extends for more than 3 mm from the ostium of the side branch:
        - No
          - Provisional SB stenting
        - Yes
          - Elective implantation of two stents (MB and SB)
Conclusions

- no two bifurcation lesions are the same
- no single strategy exists to be employed in every bifurcation
- individualized lesion-specific approach and optimization of the performance of the technique
- routine implantation of two DES in bifurcation lesions does not improve either angiographic or clinical outcomes for most patients
- the provisional strategy should be default approach in most bifurcation lesions
What’s the key to bifurcations?

The Side Branch:
Size, Length, Location, Complexity and Angulation ultimately determine optimal bifurcation therapy

Lesions suitable for provisional approach are those with SB disease confined to or extending <5 mm from the ostium, whereas lesions with more extensive SB disease and/or a steep bifurcation angle (<60–70°) are best treated with a two-stent technique

achieving optimal stent expansion/apposition across the ostia of both bifurcation branches is crucial and likely more important than the particular two-stent technique used

FFR, IVUS, OCT
Examples of phenomena known or anticipated to have fractal features:

- clouds
- river networks
- fault lines
- mountain ranges
- craters
- lightning bolts
- coastlines
- snow flakes
- various vegetables (cauliflower and broccoli)
- animal coloration patterns
- heart rates
- heartbeat
- earthquakes
- snow flakes
- crystals
- blood vessels and pulmonary vessels
- ocean waves
- DNA